MERRIMACK RIVER BASIN
PEPPERELL, MASSACHUSETTS

PEPPERELL PAPER CO. DAM

MA 00373

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02154

AUGUST 1978

~~Sample review comments by reviewer.~~

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS
DRAFT REPORT REVIEW COMMENTS
Pepperell Paper Co. DAM, IDENTITY NO. MA 00373
Foundations & Materials BRANCH

FOUNDATIONS & MATERIALS BRANCH

Page No.	Comments
General	(1) See "Boiler Plate" package for cover and flysheet
	(2) Follow format. Include all items including those not applicable which should be noted N/A
ii	(3) Brief Assessment: Second Paragraph - Use condition terminology given in "Boiler Plate"
	(4) " Last Paragraph - Revise to agree with recommendations in Section 7"
iv	(5) Insert name of dam

Page No.	Comments
2	(6) Par 1.2 f: Doesn't owner have employee designated to operate dam?
	(7) Par 1.2 h: Include approximate date of construction.
2-4	(8) Pars. 1.3 b thru 1.3 h: Item headings should be included
5	(9) Par. 2.2: Include approximate date of construction.
	(10) Par 2.4: See format.
6	(11) Par 3.1a: Should include statement of general appearance of dam and appurtenant structures at time of inspection.
	(12) Par 3.1c: Use condition terminology given in "Boiler Plate".

Page No.	Comments
6	(13) Par 3.2: Revise to give a general evaluation of condition for dam and appurtenant structure based on results of visual inspection.
9	(14) Par. 6.1 b. Delete reference to stability analysis.
	(15) Par 6.1 c. Revise to read: "This dam is located in Seismic Zone 2 and a seismic analysis is not required according to the recommended guidelines."
10	(16) Par 7.1 a - Describe condition in prescribed terminology - see comment (3)
	(17) Par 7.1 b - Revise similar to ATTACHMENT
	(18) Par 7.1 c - Give time frame - see "Bailer Plate

Page No.		Comments
10	(19)	Par. 7.2 - Only items involving additional engineering investigation or major modifications to the dam should be in this paragraph.
	(20)	Par 7.3a Revise to "Not applicable"
	(21)	Par 7.3b Add any of the items now in 7.2 which do not require engineering investigation and warning systems.
App. B	(22)	2.6b reference to stability analysis

b. Adequacy of Information. The information available is such that the assessment of the condition of the dam must be based primarily on the visual inspection.

ATTACHMENT #1

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MA 00373	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Pepperell Paper Co. Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE August 1978 13. NUMBER OF PAGES 37
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack Tiver Basin
Pepperell, Massachusetts
Nashua River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The spillway is about 275 ft. long and 21 ft. high. The dam is in fair condition with some spalling of repair work previously performed on the downstream surface. It is intermediate in size and has a hazard potential of significant. A failure of the dam could result in destruction of industrial buildings and dwellings downstream of the dam and would possibly threaten human life.

FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

OCT 26 1978

Honorable Michael S. Dukakis
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor Dukakis:

I am forwarding to you a copy of the Pepperell Paper Co. Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, the Pepperell Paper Co., Main Street, Pepperell, Massachusetts 01463.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

PEPPERELL PAPER CO. DAM

MA 00373

MERRIMACK RIVER BASIN
PEPPERELL, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	MA 00373
Name of Dam:	Pepperell Paper Co.
Town:	Pepperell, Massachusetts
County and State:	Middlesex County, Massachusetts
Stream:	Nashua River
Date of Inspection:	June 14, 1978

BRIEF ASSESSMENT

The Pepperell Paper Co. Dam is an almost 80-year old concrete, ungated spillway structure with flashboards. The spillway is about 275 feet long and 21 feet high. The abutments are more or less integral with the surrounding land and a highway which crosses a concrete bridge just downstream from the dam. The reservoir is used for power, a penstock at the right abutment serving a downstream hydroelectric power plant. Freeboard between the crest and the abutment sections is 6 feet.

The dam is in fair condition with some spalling of repair work previously performed on the downstream surface. There is some undercutting at the downstream toe. The penstock and gate house are in fair condition. Part of the abutments would probably be the first sections to fail in the event of overtopping.

Owing to the impoundment storage, Pepperell Paper Co. Dam falls within the intermediate size classification. It is in the significant hazard potential category and thus hydraulically analyzed using the full probable maximum flood.

Routing of the flood through the reservoir will reduce the maximum probable discharge of 196,000 cfs to a test flood of 172,000 cfs. The spillway can pass only 13,000 cfs (7.5 percent of the test flood). In the event of the occurrence of the test flood, the abutments would be overtopped by some 13 feet. In this situation the dam would become submerged and of no consequence.

A failure of the dam coincident with full spillway discharge could result in a flow of about 25,000 cfs which would cause destruction of industrial buildings and dwellings downstream of the dam and would possible threaten human life.

Additional investigations or major modifications are not required. However, the owner should implement inspection and maintenance procedures, make needed repairs and minor modifications, clear the spillway discharge channel of growth and debris, and develop a flood warning system.

Gustav A. Diezemann, P. E.
New York State Lic. 027062

This Phase I Inspection Report on the Pepperell Paper Co. Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

SEP 15 1978

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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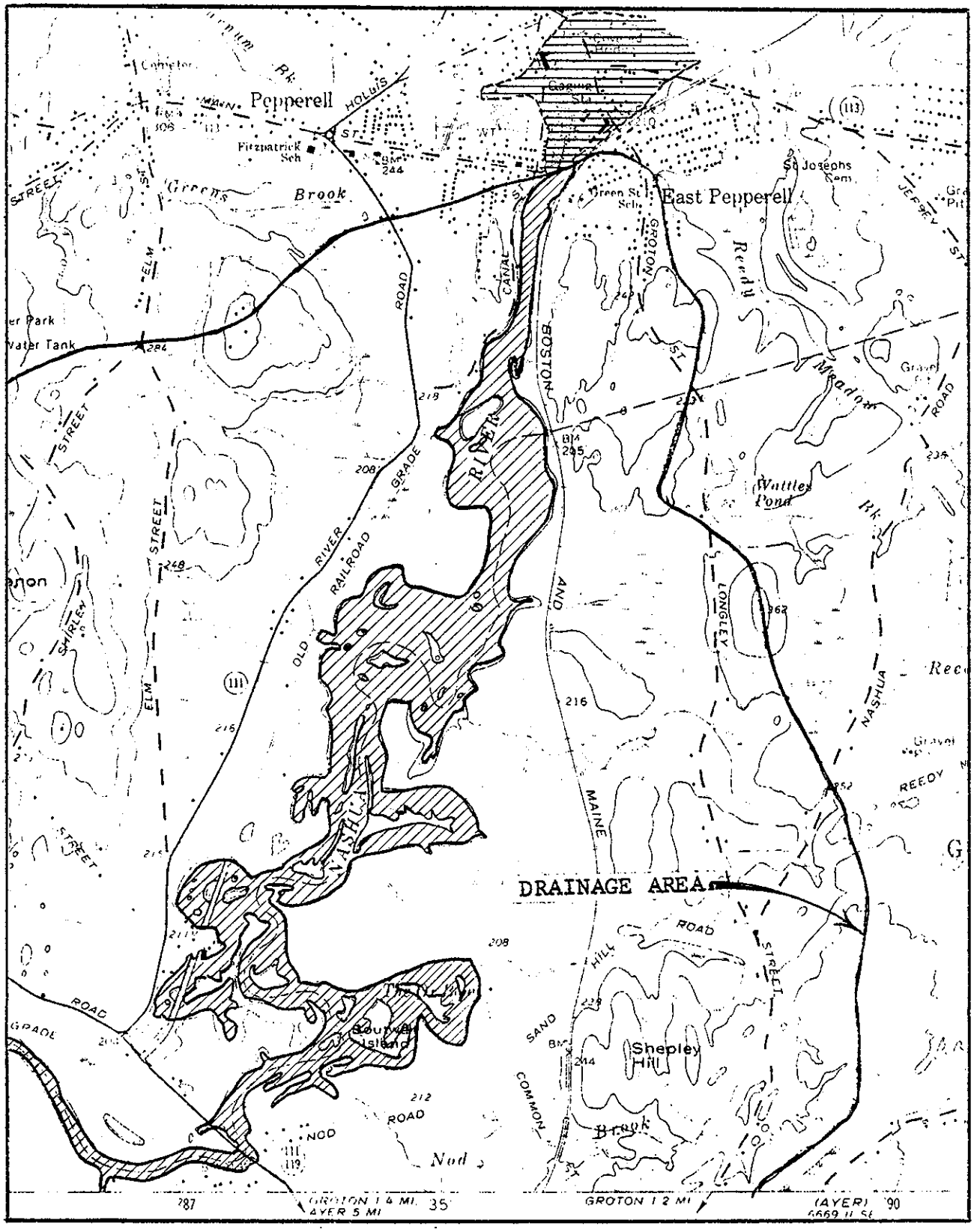
OVERVIEW PHOTO



PEPPERELL PAPER CO.

PEPPERELL, MASS.-N.H.
Scale 1:24000

PHASE I INSPECTION REPORT

PEPPERELL PAPER CO. DAM

SECTION I

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Chas. T. Main, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Chas. T. Main, Inc. under a letter of May 3, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-D328 has been assigned by the Corps of Engineers for this work.

b. Purpose.

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of the Project

a. Location. The Pepperell Paper Co. Dam, on the Nashua River, is located in the Town of Pepperell, Middlesex County, Massachusetts.

b. Description of Dam and Appurtenances. The dam consists of a concrete gravity ogee section about 275 feet long and 21 feet above stream bed. The abutments, 6 feet above the spillway crest, are probably fill to approximate natural grade behind concrete retaining walls, and bounded on downstream side by the highway. At the right abutment, flow to a 13-foot diameter wood stave penstock leading to a downstream hydroelectric power plant is controlled by headgates. Three-foot high flashboards are kept permanently in place on the spillway.

c. Size Classification. The height from stream bed to top of dam is 27 feet. However, its impoundment of roughly 4,000 acre feet below the crest falls within the intermediate size classification.

d. Hazard Classification. As there are houses and other structures downstream of the dam which would be endangered if the dam failed, the dam is considered to have significant hazard potential.

e. Ownership. The dam and power plant are owned by the Pepperell Paper Co., located on Main Street in East Pepperell, Massachusetts.

f. Operator. Raymond Bastarache
15 Scott Road, West Townsend, Mass.
(617) 597-8949

g. Purpose of Dam. The dam is used to create a head for the production of hydroelectric power.

h. Design and Construction History. The dam was constructed about 1900. Other than a drawing from which critical dimensions were obtained, nothing is known of the design and construction history of this project.

i. Normal Operating Procedures. The penstock headgates are normally kept open to permit flow to the turbine. The flashboards are normally kept in place to increase the head.

1.3 Pertinent Data

a. Drainage Area. The Nashua River at Pepperell has a drainage area of 316 square miles, or approximately 200,000 acres, varying from essentially flat to gently rolling, semi-forested rural land.

b. Discharge at Damsite.

(1) There are no outlet works, per se, only the 13-foot diameter penstock serving the hydroelectric power plant.

(2) The maximum known flood at the damsite was 21,000 $\pm$ cfs.

(3) The ungated spillway capacity before the dam is overtopped is about 13,000 cfs, or approximately 7½ percent of the test flood.

(4) There is no gated spillway capacity.

(5) There is no gated spillway capacity.

(6) The total spillway capacity at maximum pool level of El. 204 is 13,000 cfs.

c. Elevation (Feet Above MSL)

(1)	Top of dam	El. 204 (assumed for comparative purposes)
(2)	Maximum design surcharge	El. 204
(3)	Full flood control pool	N/A
(4)	Recreation pool	N/A
(5)	Spillway crest (gated)	El. 198 ± (ungated)
(6)	Upstream portal invert diversion tunnel	N/A
(7)	Streambed at centerline of dam	El. 177 ±
(8)	Maximum tailwater	El. 216 ±

d. Reservoir (Feet)

(1)	Length of maximum pool	12,000 ±
(2)	Length of recreation pool	N/A
(3)	Length of flood control pool	N/A

e. Storage (Acre-Feet)

(1)	Recreation pool	4,200
(2)	Flood control pool	N/A
(3)	Design surcharge	6,600
(4)	Top of dam	6,600

f. Reservoir Surface (Acres)

(1)	Top of dam	1,465 ±
(2)	Maximum pool	1,465 ±
(3)	Flood control pool	N/A
(4)	Recreation pool	N/A
(5)	Spillway crest	400 ±

g. Dam

(1)	Type	Concrete spillway section
(2)	Length	275 ± feet
(3)	Height	27 ± feet
(4)	Top Width	N/A
(5)	Side slope	N/A
(6)	Zoning	N/A
(7)	Impervious core	N/A
(8)	Cutoff	Unknown
(9)	Grout curtain	Unknown
(10)	Other	N/A

h. Spillway

(1)	Type	Concrete ogee section
(2)	Length of weir	275 ± feet
(3)	Crest elevation	El. 198
(4)	Gates	None
(5)	U/S Channel	N/A
(6)	D/S Channel	Riverbed
(7)	General	Riverbed channel, 200 ± feet wide

i. Regulating Outlets. Other than the wood stave penstock, there are no regulating outlets.

SECTION 2

ENGINEERING DATA

2.1 Design

There is one drawing available showing the general dimensions of the spillway. This drawing is in the offices of the Pepperell Paper Co. located on Main Street in East Pepperell 01437. Other than this drawing, there are no design data nor records available.

2.2 Construction

The Pepperell Paper Co. dam was built around 1900. There are no detailed construction records available.

2.3 Operation

The reservoir furnishes water to the hydroelectric power plant. Inflow to the reservoir exceeding the demand of the power plant is spilled over the flashboards. No operation records are available and there is no daily record kept of pool elevation or rainfall at the damsite.

2.4 Evaluation

a. Availability. Other than the one drawing mentioned above, there are no engineering data available.

b. Adequacy. The lack of in-depth engineering data does not allow for a definitive review. Therefore, the adequacy of this dam, structurally and hydraulically, cannot be assessed from the standpoint of design calculations, but must be based primarily on the visual inspection, past performance history, and sound hydrologic and hydraulic engineering judgment.

c. Validity. The limited data available does not furnish a proper basis for a detailed evaluation of this dam.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. A visual inspection of the dam was made on June 14, 1978. A copy of the inspection checklist is included in Appendix A. The concrete spillway section fills what was probably close to the normal width of the river at this point. A modern highway bridge crosses the downstream channel at about the toe of the spillway. The general appearance of the dam and appurtenant structures was in fair condition.

b. Dam. The concrete overflow section had many areas on the downstream face which showed major spalling and abrasion. At one time the downstream face was repaired by spraying with gunite. Many areas of the gunite have since peeled off with the reinforcement bars exposed. There is some undercutting of the toe. The abutments are integral with the surrounding natural grade and highway. On the event of overtopping, water would flow between the downstream side of the abutments and the upstream side of the highway bridge.

c. Appurtenant Structures. The penstock headgate structure is a part of the abutment structure and it appears to be in fair condition.

d. Reservoir Area. Upstream of the Town of Pepperell, the reservoir is located in generally flat, swampy areas with only a few houses on or near its perimeter.

e. Downstream Channel. The downstream channel is a rocky reach approximately 200 feet wide with industrial buildings on the plain above the left bank. Within the channel on the right side is the wood stave penstock on concrete supports. The hydroelectric power plant is at the end of the channel.

3.2 Evaluation

Based on visual observations during the site examination, the general condition of the project is fair. Although concrete surfaces, especially at the downstream face of the dam, have experienced considerable spalling and deterioration, these present conditions should not have any serious effect on the performance of the dam. However, this condition should be corrected before further deterioration occurs, which could create hazardous conditions in the future.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures

Other than a daily visit by someone from the power plant, there is no formal operating procedure at the dam. The sluice gate at the penstock is left open and the flashboards remain in place.

4.2 Maintenance of Dam

While the dam has been repaired, mainly cosmetically in the past, no recent maintenance is apparent.

4.3 Maintenance of Operating Facilities

The owner periodically clears the trash which accumulates in front of the flashboards, and the flashboards are replaced if they are damaged. Obviously, the penstock and its appurtenances are maintained.

4.4 Warning System

There is no warning system.

4.5 Evaluation

Apart from the operation of the hydroelectric plant, operating procedures are minimal. Recommendations for improving this situation are given in Section 7.3.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data. The hydraulic/hydrologic analysis was made in accordance with "Preliminary Guidance for Estimating Maximum Probable Discharges in Phase I Dam Safety Investigations", "Estimating Effect of Surcharge Storage on Maximum Probable Discharges", and "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs" as furnished by the New England Division, Corps of Engineers and "Recommended Guidelines for Safety Inspection of Dams" as issued by the Department of the Army, Office of the Chief of Engineers.

U.S.G.S. Quadrangle maps were used to determine reservoir and drainage areas. Where practicable, spillway dimensions were obtained by direct measurement. Hydraulic coefficients were assigned on the basis of experience and engineering judgment.

b. Experience Data. There is a U.S.G.S. gaging station located about 800 feet downstream of the dam. Using published data, a rating curve was developed for use in analyzing large flows in this reach of the river. This curve appears in Appendix D.

c. Visual Observations. It was observed that high flows would obviously discharge over a length greater than the dam itself. A total effective length of 700 feet, inclusive of the 275-foot spillway, was assumed. At either end of the spillway section, overtopping of the abutments would result in flows between the downstream face of the abutment sections and the upstream side of the highway bridge.

d. Overtopping Potential. A Probable Maximum Flood (PMF) of 196,000 cfs was determined. This flood was routed through the reservoir taking into consideration the incrementally increasing available storage as the reservoir level rises and the effect of discharge over the dam during the flood period. The resulting peak outflow of 172,000 cfs was adopted as the test flood. The spillway has the capability of discharging only about 13,000 cfs before the abutments are overtopped. The test flood would overtop the spillway section by about 19 feet and the abutment and adjacent low sections by about 13 feet.

According to the established rating curve for the reach below the dam, the test flood would produce a water level of approximately El. 216. As this level corresponds closely to the headwater level at this discharge, the dam would be submerged and of little or no consequence. The covered bridge would serve as a contraction, creating significant backwater at this flow.

The Peak Failure Outflow of approximately 12,000 cfs, combined with the spillway discharge at full pond, results in a flow of about 25,000 cfs. This exceeds the flood of record, 21,000 cfs, by less than 20 percent and would result in a water level in the channel of about El. 190, the majority of flow being primarily contained within the channel. The covered bridge, located downstream, passes the peak failure outflow with no apparent problem, creating only a small backwater effect through the channel. Flooding to residences along the bank, including the mill, would take place consequent to a flow of this magnitude. Human life should not be endangered.

The areas of impact immediately downstream of the dam are shown on the location map.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Nothing was noted which would indicate that the dam is unstable.

b. Design and Construction Data. No design nor construction data are available other than a cross-section of the spillway.

c. Operating Records. Not applicable.

d. Post Construction Changes. No post construction changes are known to have been made.

e. Seismic Stability. This dam is located in Seismic Zone 2 and therefore a seismic analysis is not required, according to the recommended guidelines.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The condition of this almost 80 year old structure is fair. However, proper repair and maintenance would stop the deterioration which, at the moment, appears not to have advanced far enough to make the integrity of the structure questionable.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

c. Urgency. The required repair and maintenance work should be accomplished within one to two years of the receipt of this report by the owner.

d. Need for Additional Investigation. There is no need for additional investigation.

7.2 Recommendations

Additional engineering investigations or major modifications to the dam are not required.

7.3 Operation and Maintenance Procedures

The owner of the dam should develop and implement procedures which would include periodic inspection of the dam and the initiation of repairs, as required. Presently required maintenance includes repair of all spalled concrete and the application of dental concrete in the undercut areas at the toe of the dam.

Other areas which require attention are the downstream faces of the abutments, upstream of the highway bridge. If the dam is overtopped, these sections would probably be the first to wash out. Paving of these faces and the adjacent horizontal surfaces is appropriate. The channel between the power plant and the spillway should be cleared, and kept clear of growth and debris.

The seepage condition at the toe of the dam should be monitored by constructing an adequate collection system and weir.

Around the clock surveillance should be provided by the owner during periods of unusually heavy precipitation. The owner should develop a formal warning system with local officials for alerting downstream residents in case of emergency.

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT PEPPERELL PAPER CO. DATE JUNE 14, 1978

TIME 2:00 P.M.

WEATHER CLEAR & SUNNY

W.S. ELEV. 203.5 U.S. ____ DN.S

PARTY:

1. J. Goodrich
2. D. Fischer
3. L. Cross
4.
5.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

1

INSPECTION CHECK LIST

PROJECT PEDDERELL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	NOT APPLICABLE
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
~~Instruments on System~~	

INSPECTION CHECK LIST

PROJECT PEPPERELL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
CONCRETE DAM	
Concrete Surfaces	Extensive Spalling
Structural Cracking	some
Movement -- Horizontal & Vertical Alignment	None
Junctions	O.K
Drains -- Foundation, Joint, Face	none
Water Passages	13'ϕ Wood Stave Penstock
Seepage or Leakage	Some seepage at toe
Monolith Joints -- Construction Joints	O.K.
Foundation	

INSPECTION CHECK LIST

PROJECT PEPPEREL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	NOT APPLICABLE
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	Gate House
Condition of Concrete	O.K.
Stop Logs and Slots	None

INSPECTION CHECK LIST

PROJECT PEPPEREL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	NOT APPLICABLE
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

INSPECTION CHECK LIST

PROJECT PEPPEREL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	None
Floor of Approach Channel	None
b. Weir and Training Walls	
General Condition of Concrete	major spalling
Rust or Staining	some
Spalling	extensive
Any Visible Reinforcing	yes, reinforcement of gunite coating
Any Seepage or Efflorescence	none
Drain Holes	-
c. Discharge Channel	
General Condition	
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	none
Floor of Channel	
Other Obstructions	partially choked with debris & vegetation

INSPECTION CHECK LIST

PROJECT PEPPERELL PAPER CO. DATE

PROJECT FEATURE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	NOT APPLICABLE
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

INSPECTION CHECK LIST

PROJECT DEPPERELL PAPER CO. DATE _____

PROJECT FEATURE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	Debris & vegetation in channel

INSPECTION CHECK LIST

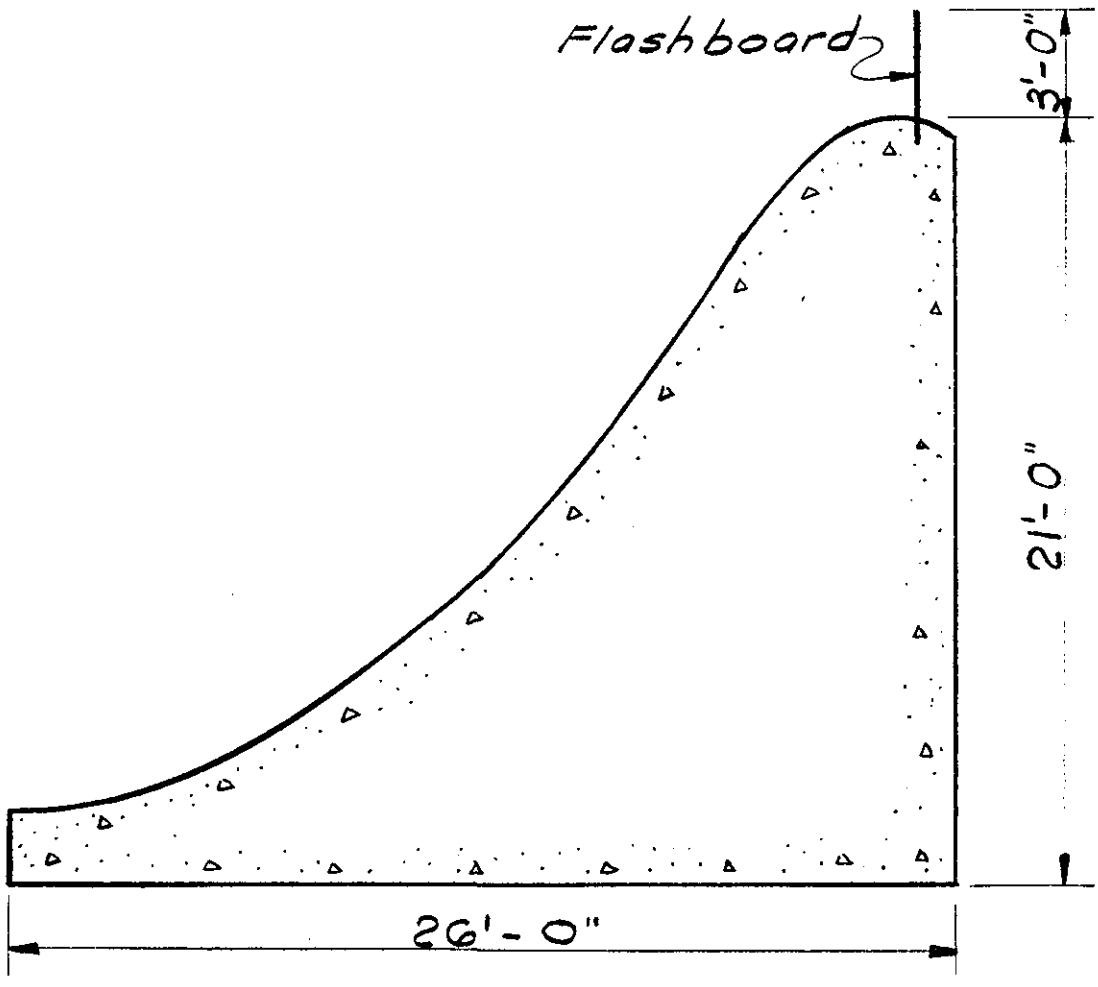
PROJECT DEPPERELL PAPER CO. DATE _____

PROJECT FEATURE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	NOT APPLICABLE
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

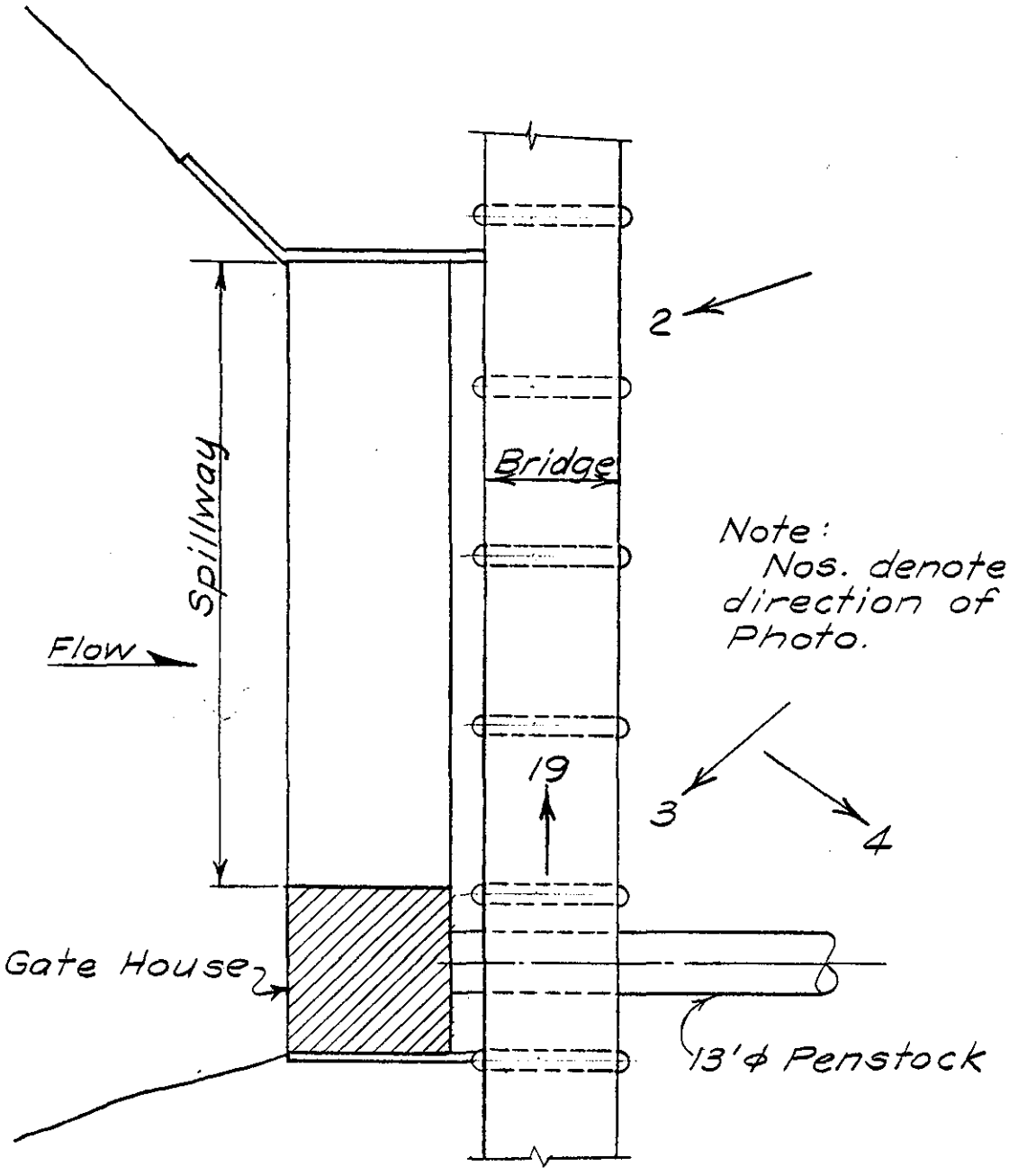
A few drawings were available at the Pepperell Paper Company in Pepperell, Massachusetts. The cross section of the spillway was copied from these drawings.



SPILLWAY CROSS SECTION

NOTE:
This cross section was copied from a drawing in possession of the Pepperell Paper Co.

APPENDIX C



PLAN

PEPPERELL PAPER CO.

Client C OF E Job No. Sheet 3 of

Subject SPILLWAY DISCHARGE (AC FT) By J. VEITCH. Date 19 JULY 1978.

—PEPPERELL— Ckd. Rev.

SPILL. $Q = CLH^{3/2}$

$C = 3.25$

$L = 275'$

DAM. $Q = CLH^{3/2}$

$C = 2.25$

$L_1 = 675$

$L_2 = 950$

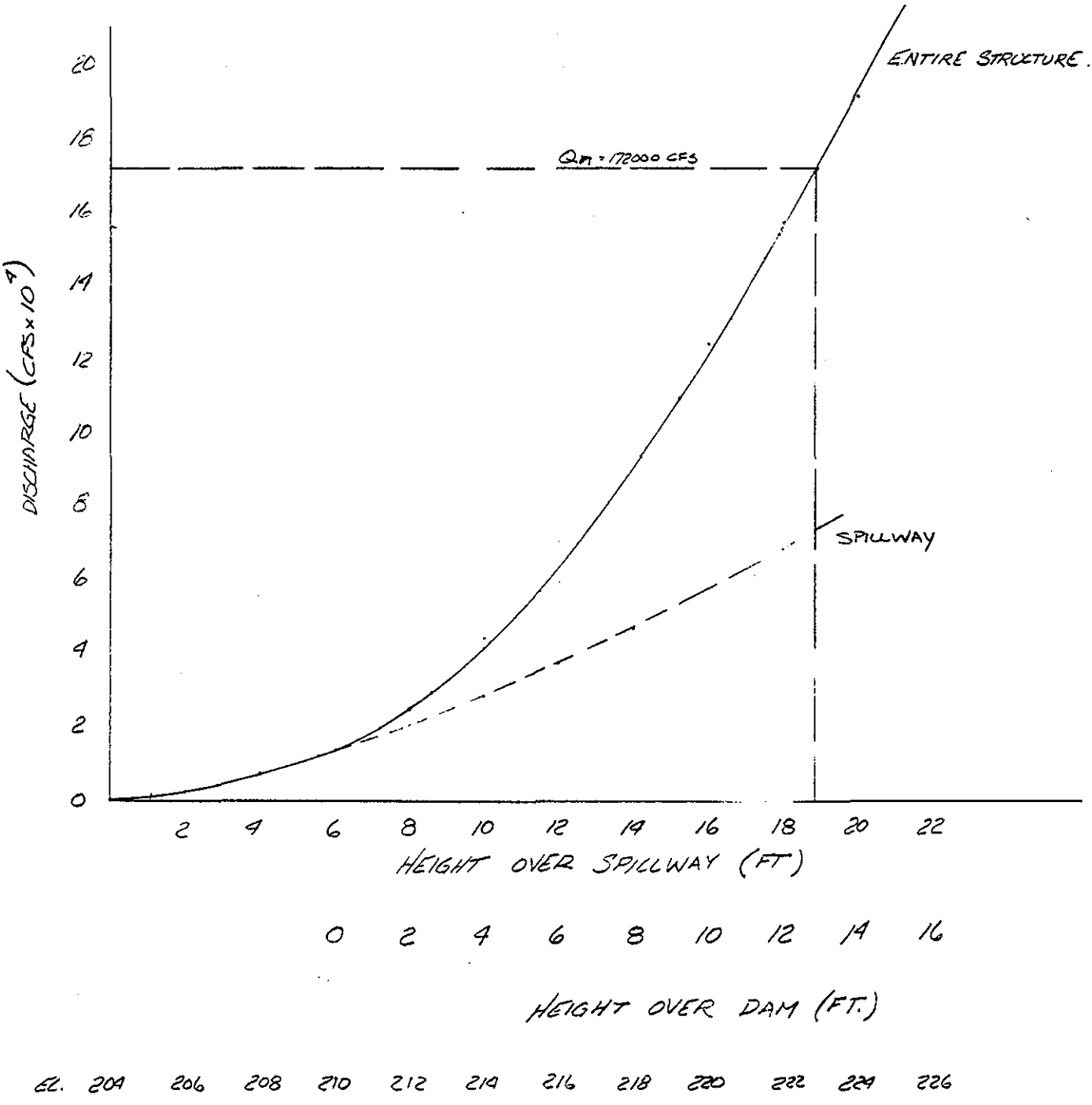
SPILLWAY EL. 203.5 DAM. 209.5

H.	Q	H.	Q	Q TOTAL	EL.
0	—			—	~209
2	2530			2530	206
4	7150			7150	208
6	13,135	0	—	13135	210
8	20,225	L_1 2	4300	24,525	212
10	28,260	4	12,150	40,410	214
12	37,150	6	22,320	59,470	216
14	46,820	8	48,365	95,185	218
16	57,200	L_2 10	67,590	124,790	220
18	68,255	12	88,855	157,110	222
20	79,940	14	111,970	191,910	224

Client C OF E Job No. Sheet 9 of

Subject – PEPPERELL – By J. VEITCH Date 20 JULY 1973

Ckd. Rev.



Client COE | Job No. | Sheet 5 of

Subject – PEDERAL – INFLOW HYDROGRAPH – ROUTING | By J. VEITCH | Date 20 JULY 1978 | Ckd. | Rev.

USING 1) PMF = 196,000 CFS ('PRELIMINARY GUIDANCE FOR EST. MAX. PROB. DISCH, PH. I.')
T_p = 39 HRS.

2) SHAPE OF THE HYDROGRAPH. p. 78 CREAGER & JUSTIN

T_p = 39 HRS. ∴ by fig 5. p 80 $T_p = .39\ D_A$

$.39\ D_A = 39$ HRS $\qquad D_A$ = base = 100 HRS. = 4.2 DAYS.

USING Fig. 80:

D/D_A	Q'/Q	T (HRS.)	Q (CFS.)
0	0	0	0
.1	.076	10	14,900
.2	.21	20	41,160
.3	.71	30	139,160
.39	1	39	196,000
.5	.37	50	72,520
.6	.21	60	41,160
.7	.125	70	24,500
.8	.07	80	13,720
.9	.035	90	6,860
1.0	0	100	0

Client C OF E Job No. Sheet 5A of

Subject – PEPPERELL – By J. Veitch Date 20 JULY 1973

ROUTING PMF Ckd. Rev.

DISCHARGE ENVELOPE (SPILLWAY & OVERTOPPING) (3 HR INTERVAL)

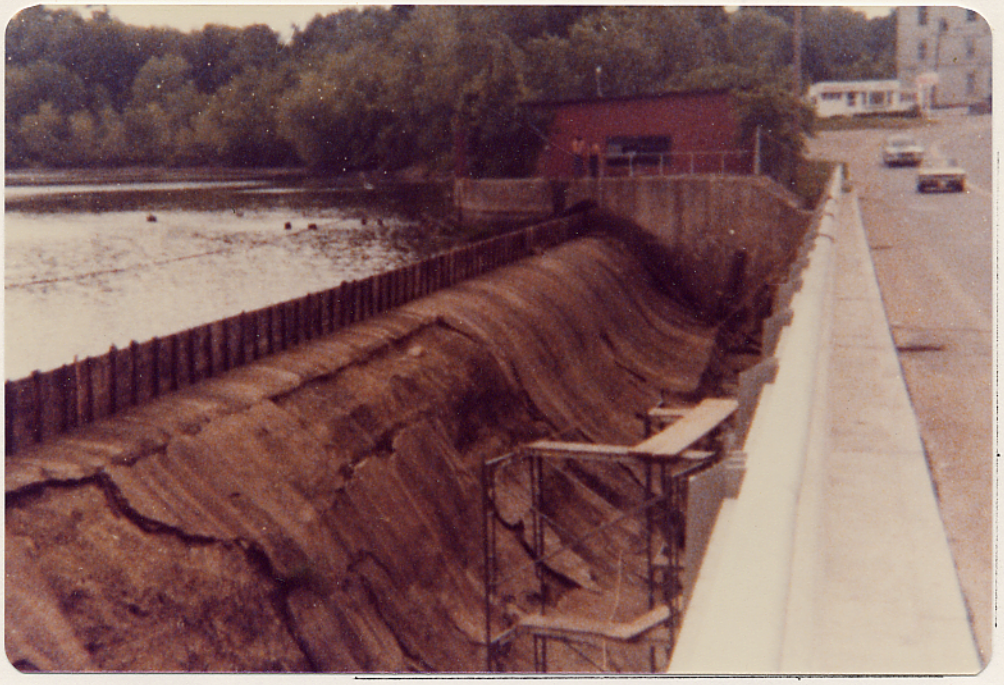
EL.	DISCHARGE ($\frac{AC.FT.}{3\ HRS}$)	Q(½)
200	–	–
202	–	–
204	–	–
206	627	314
208	1773	887
210	3257	1629
212	6080	3040
214	10020	5010
216	14 745	7373
218	23600	11800
220	30940	15470
222	38955	19478
224	47580	23790

Client CORP OF ENG. Job No. _____ Sheet 58 of _____

Subject PEPPERELL By J. VEITCH Date 24 JULY 1975

ROUTING. Ckd. _____ Rev. _____

TIME. (HRS.)	INFLOW CFS.	AVE. INFLOW AC-FT.	RES. EL. (FT.) @ 204	SPILLWAY DISCHARGE (CFS.)
0	2250	280	204.0	—
3	5000	900	205.1	1250
6	7500	1550	206.4	3250
9	12500	2480	207.9	7000
12	18000	3780	209.6	12000
15	25000	5330	211.2	19000
18	34000	7315	212.6	29000
21	46000	9920	214.0	41500
24	66500	13950	215.5	57250
27	98000	20395	218.2	93750
30	140000	29505	219.0	106000
33	170000	38930	220.6	131000
36	188000	44380	221.9	154000
39	196000	47600	222.8	171000
42	175000	45990	222.8	171000
45	134000	38305	221.5	147500
48	85000	27150	219.2	109500
51	67000	18845	217.3	81000
54	56000	15250	216.2	65000
57	48000	12895	215.6	58500
60	41000	11035	215.0	
63	36000	9545	214.4	
66	31000	8305	213.6	
69	26000	7070	213.0	
72	22000	5950	212.3	



19

Downstream View of Spillway

3

Downstream Face of Dam taken
from Downstream Channel

PEPPERELL PAPER CO.

4

Downstream Channel and
13ft. Dia. Penstock

2

Downstream Toe of Dam

APPENDIX D

Client C OF E Job No. _____ Sheet 1 of _____

Subject PEPPERELL MA. By J. VEITCH Date 19 JULY 1978

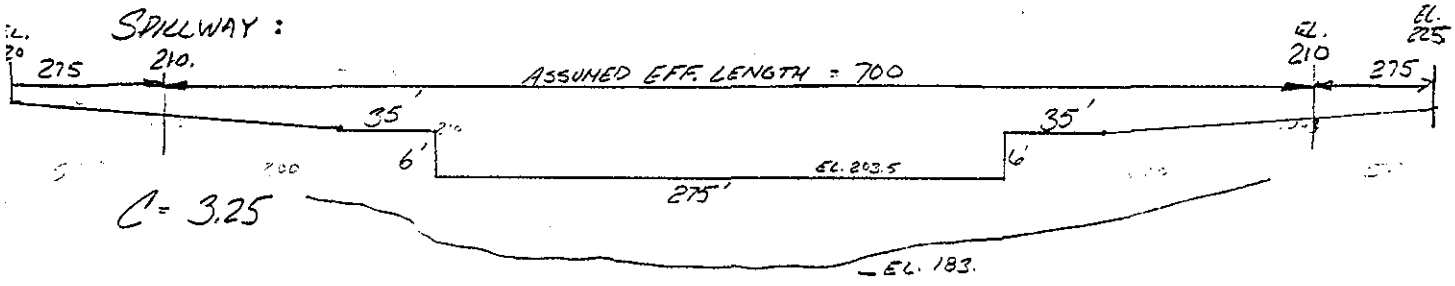
_____ Ckd. _____ Rev. _____

PMF = 196,000 CFS.

RES. AREA = 408 AC.

DRAINAGE AREA = 316 mi^2 = 202,240 AC.

SPILLWAY :

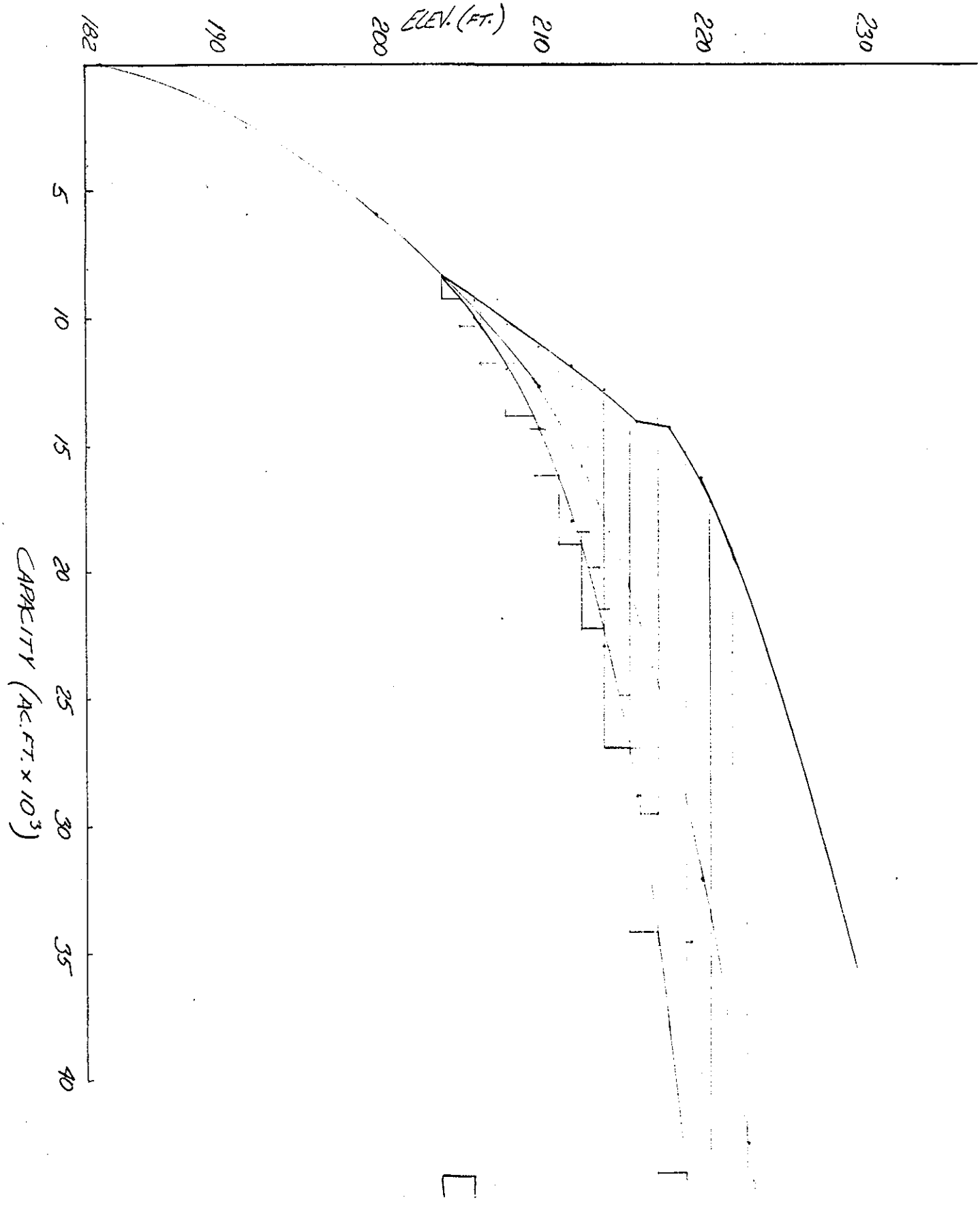


L.A. R.A

Client C. OF E. Job No. Sheet 2 of

Subject PEPPERELL RES. By J. VEITCH Date

— CAPACITY CURVE — Ckd. Rev.



Client CORP OF ENG. 200

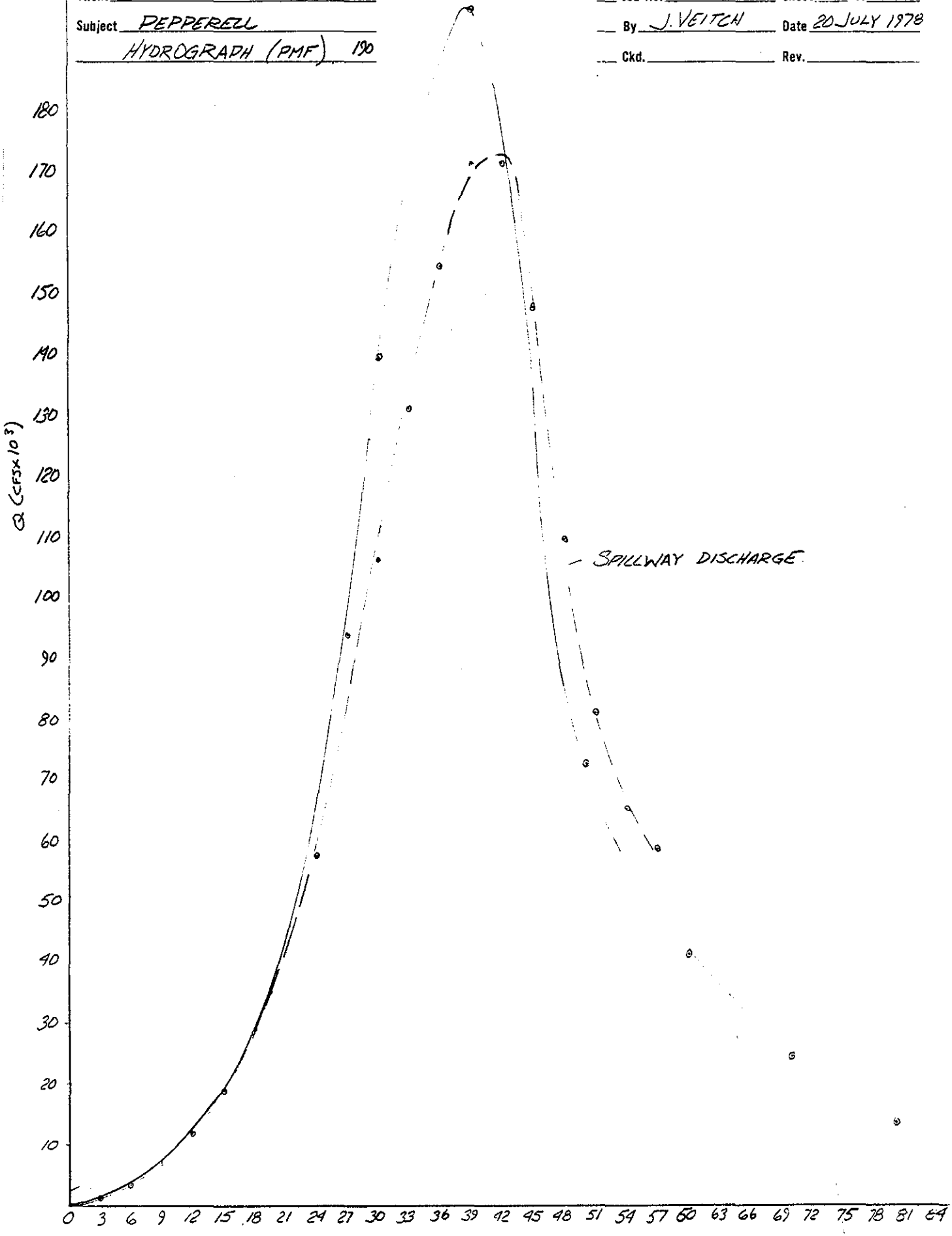
Subject PEPPERELL

HYDROGRAPH (PMF) 190

Job No. ____ Sheet 6 of ____

By J. VEITCH Date 20 JULY 1978

Ckd. ____ Rev. ____



Client C OF E Job No. _____ Sheet 7. of _____

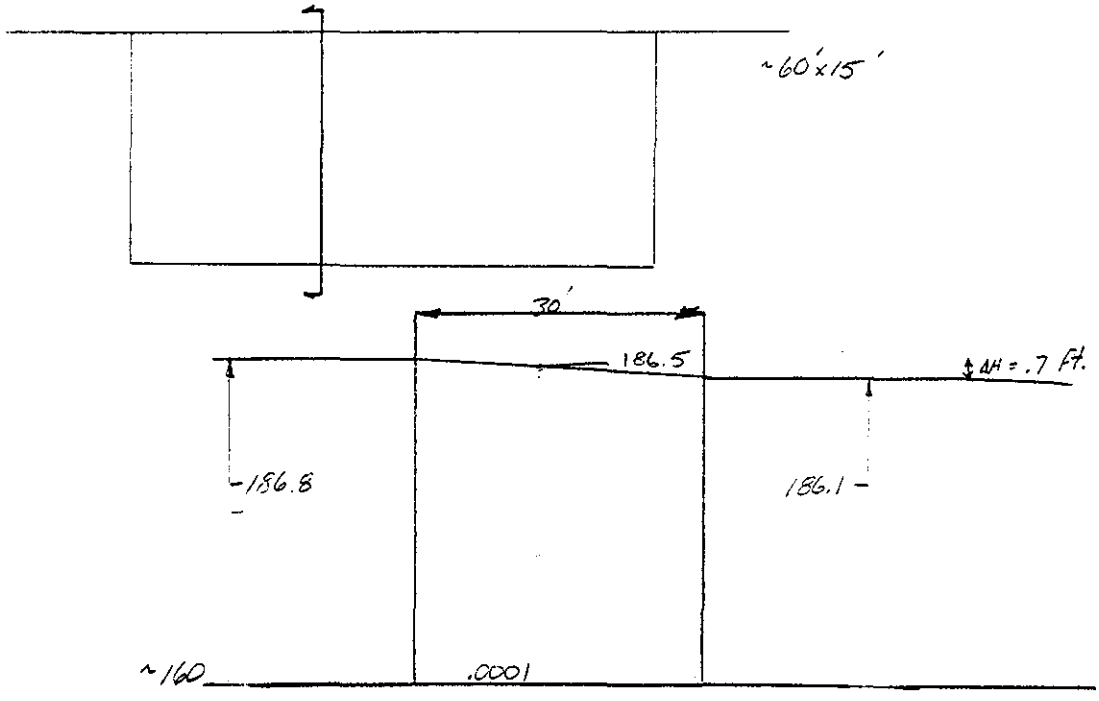
Subject PEPPERELL By J. Vertel Date 25 JULY 1978

RATING CURVE @ GAGING STA. Ckd. _____ Rev. _____

FROM FLOODS OF MAR. '36 PART I N.E. RIVERS.

DATE	GAGE HT. (FT.)	Q (CFS)
MAR 13	10.0	4650
	13.0	8180
MAR 18.	7.0	3200
19.	15.0	11,700
	16.0	13,600
	17.0	15,600
	19.0	20,600

CONTRACTION - COVERED BRIDGE.



n = .013

Q = 20,900 CFS.

Client C OF E Job No. Sheet 7A of

Subject PEPPERELL By J. VEITCH Date 29 JULY 1978

Ckd. Rev.

REALIZING AMOUNT OF STORAGE UPSTREAM & USING ROUTED PEAK.

ROUTED PMF = 172000 CFS. = Q_{P1}
CLASS : H/INT.
RESERVOIR AREA = 408 ACRES.
DRAINAGE AREA = 316 mi^2 = 202,240 AC.

SURCHARGE TO PASS Q_{P1} = (FROM CURVE) = 12.8'

STOR, (USING CAPACITY CURVE) CAPACITY 210 − 222.8 = 29800 AC FT.

$$STOR_1 = \frac{29800 \text{ AC FT } (12)}{202\,240} = 1.77''$$

USING RATING CURVE DERIVED FROM GAGING STATION RECORDS.
WATER ELEV @ Q OF 172,000 CFS. = EL. 215' THEREFORE MUCH OF PEPPEREL NEEDLESS TO SAY THE FACTORY & POWERPLANT JUST DOWNSTREAM OF THE DAM WOULD BE IN DANGER OF EXCESSIVE PROPERTY DAMAGE, COVERED BRIDGE CREATING A contraction would tend to increase backwater effects

PEAK FAILURE OUTFLOW:

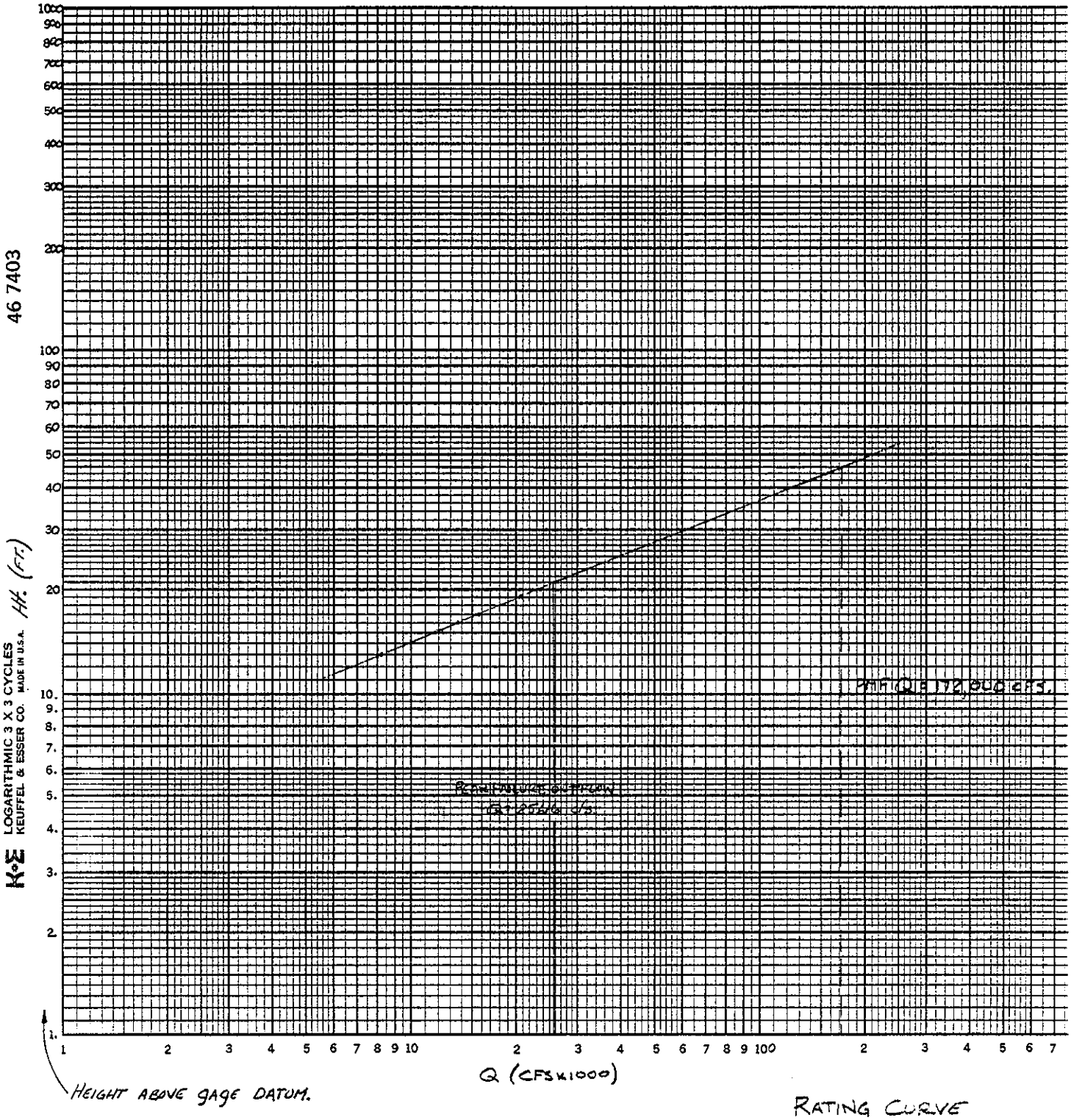
$W_b = .3(275') = 93'$
$Y_o = 20'$

$$Q_{P1} = \frac{8}{27}(83)\sqrt{32.2}(20)^{1.5}$$

= 12,481. CFS. + 13,135 cfs = 25,616 AC FT.

RESULTING EL. 190.0'

PRIMARILY CONTAINED WITHIN CHANNEL. POSSIBLE DAMAGE (EROSION) TO FACTORY AND PROBABLE DAMAGE TO PUMPSTOCK AND POWERHOUSE, COVERED BRIDGE DOWNSTREAM WILL PASS THE P.F.O. WITHOUT APPARENT PROBLEM.



RATING CURVE
@ E. PEPPERELL GAGING STA
24 JULY 1978
GAGE DATUM = 1620

Client C of E | Job No. | Sheet 9 of

Subject PEPPERELL | By J. VEITCH | Date 25 JULY 1978.

Ckd. | Rev.

$h_e = .1\ V^2/2g$

$h_o = .3\ V^2/2g$

Neglect Flow losses (30')

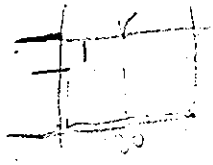
$\Delta H = .7' = .4 \frac{V^2}{2g}$

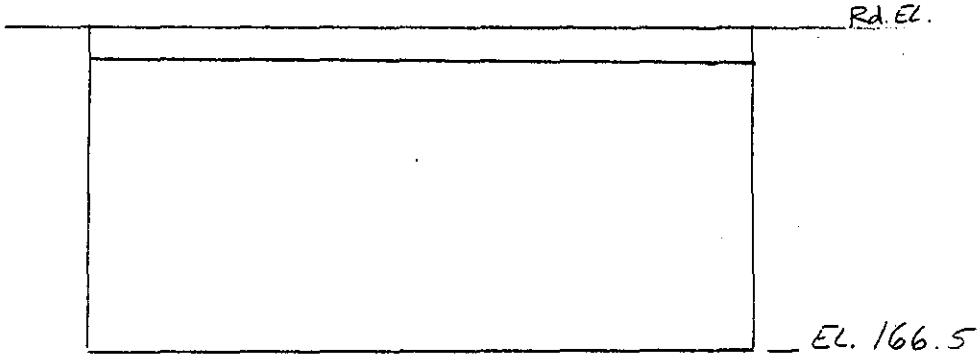
$V = 10.6$ FT/SEC.

$Q = VA$

$V = \frac{20900}{10.6} = 1972$ FT.^{2}

$20 \times 100'$





ASSUME BOX CULVERT 100' W 30' LONG. $Q = \frac{1.49}{.013} A R^{2/3} S^{1/2}$.

22' H $S = \sqrt{.0005}$

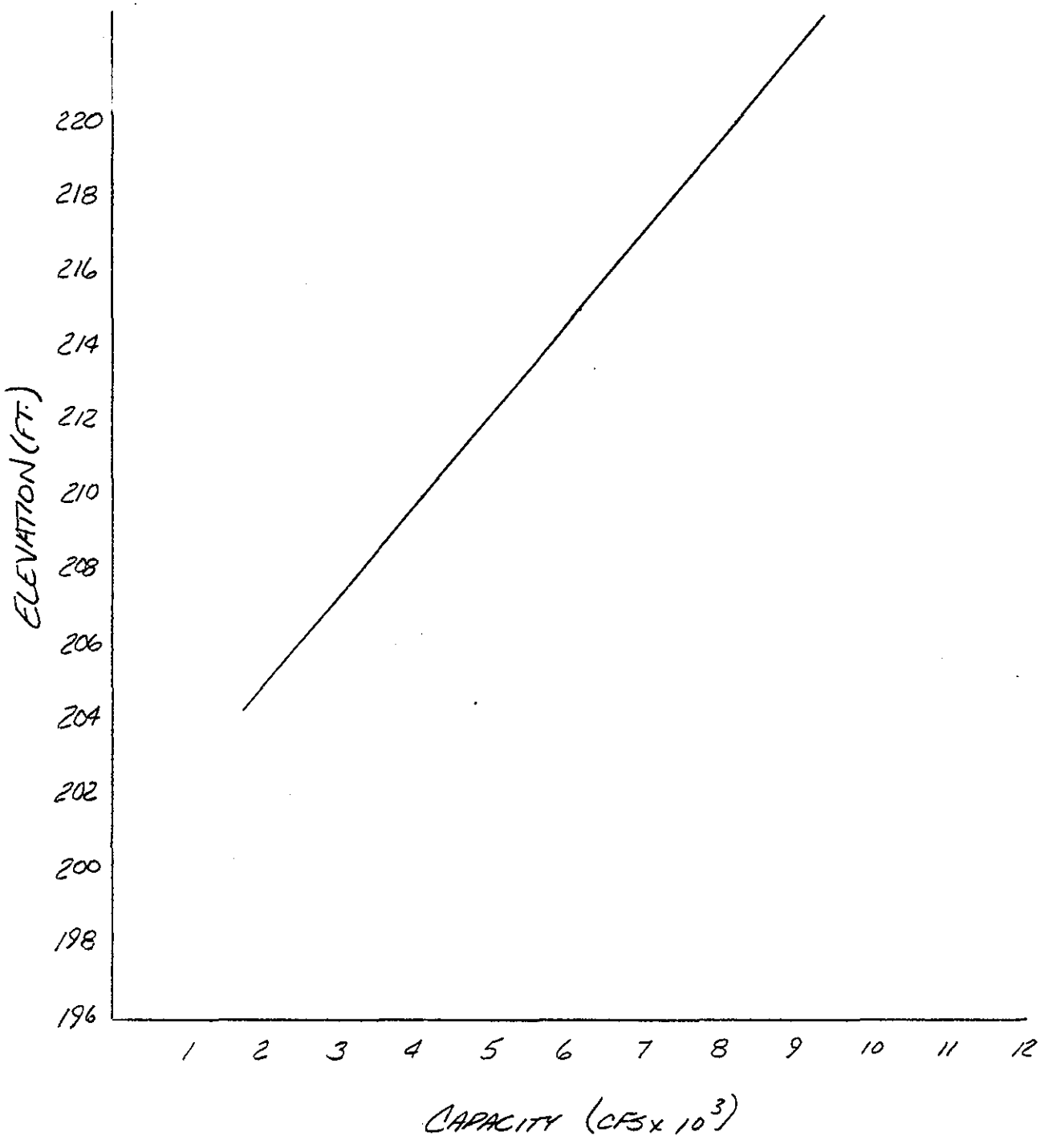
H	A	W.P	$R^{2/3}$	Q CFS.
2	200	104	1.55	800
4	400	108	2.39	2450
6	600	112	3.06	4705
8	800	116	3.62	7420
10	1000	120	4.11	10530
12	1200	124	4.54	13960
14	1400	128	4.93	17690
16	1600	132	5.28	21650
18	1800	136	5.60	25835
20	2000	140	5.89	30190
22	2200	144	6.16	34730

PEAK FAILURE OK.

Client C OF E Job No. _____ Sheet 10 of _____

Subject PEPPERELL By J VEITCH Date 25 Aug. 1978

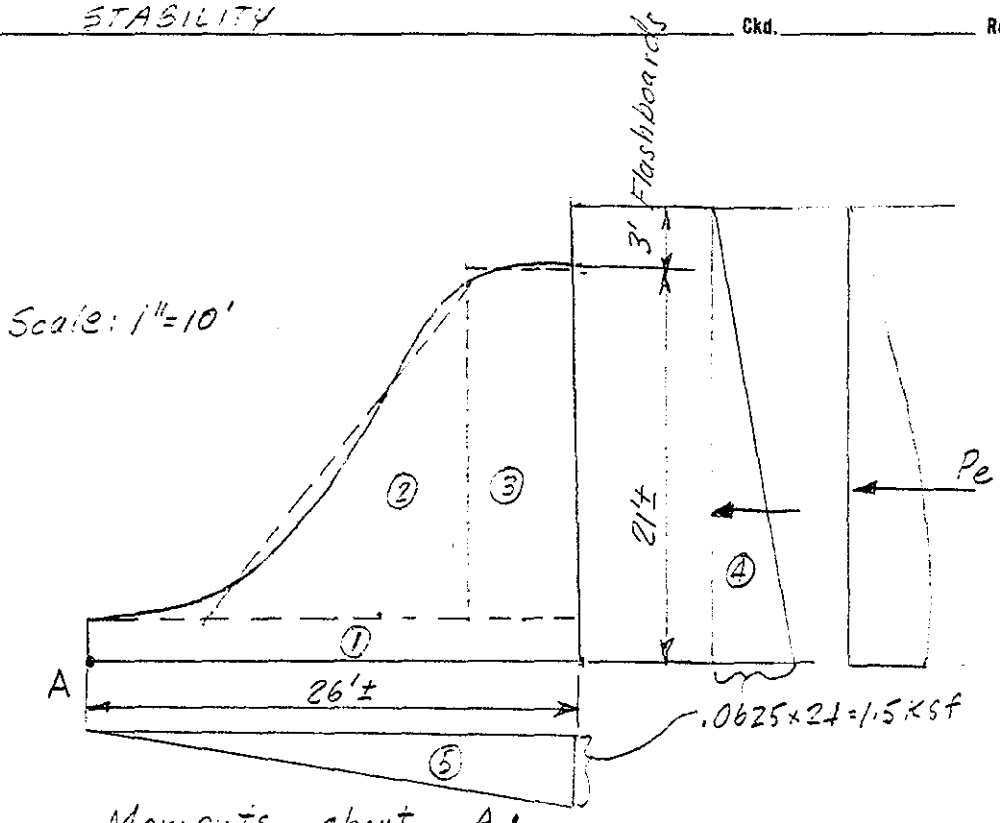
CAPACITY CURVE Ckd. _____ Rev. _____



Client _____ Job No. _____ Sheet 1 of _____

Subject PEPPERELL PAPER CO. By DJF Date 7/21/78

STASILITY Ckd. _____ Rev. _____



Moments about A:

① $\overbrace{2\times 26\times .15}^{7.8^K}\times 13 = 101.4^{IK}$

② $14\times\frac{19}{2}\times 0.15\times 15.5 = \overbrace{226.8}^{18.9^K}\ ^{IK}$

③ $5\times 19\times 0.15\times 23 = \overbrace{393.3}^{17.1}\ ^{IK}$

787.7^{IK}

④ $\overbrace{.0625\times 24\times\frac{24}{2}}^{18K}\times\frac{2}{3}\times 24 = 144^{IK}$

⑤ $\underbrace{.0625\times 24\times\frac{26}{2}}_{19.5^K}\times\frac{2\times 26}{3} = 338^{IK}$

482^{IK}

$\Sigma M_A = 787.7 - 482 = 305.7^{IK}$

$\Sigma V = (7.5+18.9+17.1) - 19.5 = 24.3^K$

$e = \frac{305.7}{24.3} = 12.58'$ (within middle third)

Client _____ Job No. _____ Sheet 2 of _____

Subject DEPPERELL PAPER CO. By _____ Date 7/21/78

STABILITY Ckd. _____ Rev. _____

EARTHQUAKE

Assume $\frac{a}{g} = 0.05$ (0.39)

① $7.8 \times .05 \times 1 = 0.39^{1K}$

② $18.9 \times .05 \times 8 = 7.56^{1K}$ (.95)

③ $17.1 \times .05 \times 11.5 = 9.83^{1K}$ (.85)

$Pe = \frac{2}{3} C_2 \alpha h_2^2 = \frac{2}{3} \times 52 \times .05 \times 24^2 = 998.4^{\#} \cong 1.0^K$

$M = 1.0 \times \frac{2 \times 24}{5} = 9.6^{1K}$

$\Sigma M_A = 305.7^{1K} - (.39 + 7.56 + 9.83 + 9.6) = 278.32^{1K}$

$\Sigma V = 24.3^K \quad e = \frac{278.32}{24.3} = 11.45'$ (within middle third)

$\Sigma H = 18 + 1 + .39 + .95 + .85 = 21.19^K$

$\frac{\Sigma H}{\Sigma V} = \frac{21.19}{24.3} = .87$ say O.K.

Base pressure at A: $\frac{\Sigma V}{\ell}\left(1 + \frac{6e}{\ell}\right)$

$= \frac{24.3}{26}\left(1 + \frac{6 \times 11.45}{26}\right)$

$= .935(3.64) = 3.41$ ksf

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
MA	373	NED	MA	017					PEPPERELL PAPER CO, DAM	4240.0	7135.0	08	SEP	78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	NASHUA RIVER

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	05	NASHUA RIVER	PEPPERELL	0	5900

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(27) IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)
CIPG	1900	H	27	21	6600	4200

DIST	DAM	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	30AUG78

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	350	U	275	13135	4000											

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
PEPPERELL PAPER CO,		

(49) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
CHAS, T, MAIN, INC	14JUN78	PL 92-367

(53) REMARKS